

CLAIMS

What is claimed is:

1. A method of forming an elongated composite structural member, the method comprising:
providing a substantially elongated mandrel having an exterior surface exhibiting a desired geometry;
laying up a plurality of plies of fiber material preimpregnated with a thermosetting resin; and
pressing the plurality of plies onto the mandrel including passing at least one roller over the mandrel and the plurality of plies along a length of the mandrel, the at least one roller being at least partially complementary in shape with the mandrel while maintaining the plurality of plies in a substantially uncured state during the pressing.
2. The method according to claim 1, wherein passing at least one roller over the mandrel and the plurality of plies includes sequentially passing a plurality of rollers over the mandrel and the plurality of plies.
3. The method according to claim 2, further comprising configuring the plurality of rollers such that a first roller partially complementarily engages the mandrel and such that a last roller substantially fully complementarily engages the mandrel.
4. The method according claim 1, wherein pressing the plurality of plies onto the mandrel further includes forming at least one intermediate structure and a final structure.
5. The method according to claim 4, wherein forming at least one intermediate structure includes forming the plurality of plies to partially conform with the exterior surface of the mandrel.
6. The method according to claim 5, wherein forming a final structure includes forming the plurality of plies to substantially fully conform to the exterior surface of the mandrel.

7. The method according to claim 1, further comprising forming the mandrel to have a first section extending along a longitudinal axis and a second section which deviates from the longitudinal axis.

8. The method according to claim 1, further comprising coupling the mandrel to a base, coupling the at least one roller to a carriage assembly, and wherein passing at least one roller over the mandrel and the plurality of plies along a length of the mandrel includes moving the carriage assembly relative to the base.

9. The method according to claim 8, further comprising controlling the movement of the carriage assembly relative to the base with computer numeric controlled controller.

10. The method according to claim 1, further comprising forming elongated composite structural member to substantially exhibit a cross-sectional geometry of a hat as taken transverse to a length of the elongated member.

11. The method according to claim 1, further comprising forming the elongated composite structural member to substantially exhibit a cross-sectional geometry of at least one C-shape as taken transverse to a length of the elongated member.

12. The method according to claim 1, further comprising forming the elongated composite structural member to substantially exhibit a cross-sectional geometry of at least one angle as taken transverse to a length of the elongated member.

13. The method according to claim 1, further comprising forming the elongated composite structural member to substantially exhibit a cross-sectional geometry including at least one arcuate section as taken transverse to a length of the elongated member.

14. The method according to claim 1, wherein pressing the plurality of plies onto the mandrel includes consolidating the plurality of plies.

15. The method according to claim 1, further comprising heating at least a portion of the plurality of plies prior to pressing the plurality of plies onto the mandrel.

16. A method of forming an elongated composite structural member, the method comprising:

laying up a plurality of plies of composite material onto an elongated mandrel having a surface exhibiting a desired geometry; and

substantially simultaneously pressing and forming a portion of the plurality of plies over the mandrel to at least partially conform the plurality of plies to the geometry of the mandrel while and maintaining the plurality of plies in a substantially uncured state.

17. The method according to claim 16, wherein laying up a plurality of plies of composite material includes laying up a plurality of plies of composite material impregnated with a thermosetting resin.

18. The method according to claim 16, further comprising infusing at least one of a thermosetting resin and a binder into the plurality of plies

19. The method according to claim 18, wherein infusing at least one of a thermosetting resin and a binder into the plurality of plies is effected substantially simultaneously with the laying up a plurality of plies.

20. The method according to claim 18, wherein infusing at least one of a thermosetting resin and a binder into the plurality of plies is effected after the laying up a plurality of plies.

21. The method according to claim 18, wherein infusing a thermosetting resin into the plurality of plies includes forming the mandrel to define a plurality of apertures therein and spraying the thermosetting resin through the plurality of apertures.

22. The method according to claim 16, wherein substantially simultaneously pressing and forming a portion of the plurality of plies includes at least partially complementarily engaging

at least one roller with the mandrel and passing the at least one roller over the mandrel and the plurality of plies along a length of the mandrel.

23. The method according to claim 22, wherein passing at least one roller over the mandrel and the plurality of plies includes sequentially passing a plurality of rollers over the mandrel and the plurality of plies.

24. The method according to claim 23, further comprising configuring and arranging the plurality of rollers such that a first roller partially complementarily engages the mandrel and such that a last roller substantially fully complementarily engages the mandrel.

25. The method according to claim 22, further comprising coupling the mandrel to a base, coupling the at least one roller to a carriage assembly, and wherein passing at least one roller over the mandrel and the plurality of plies along a length of the mandrel includes moving the carriage assembly relative to the base.

26. The method according to claim 25, further comprising controlling the movement of the carriage assembly relative to the base with computer numeric controlled controller.

27. The method according claim 16, wherein substantially simultaneously pressing and forming a portion of the plurality of plies further includes forming the elongated member as at least one intermediate structure and as a final structure.

28. The method according to claim 27, wherein forming at least one intermediate structure includes forming the plurality of plies to partially conform with the exterior surface of the mandrel.

29. The method according to claim 28, wherein forming a final structure includes forming the plurality of plies to substantially fully conform to the exterior surface of the mandrel.

30. The method according to claim 16, further comprising forming the mandrel to have a first section along a longitudinal axis and a second section which deviates from the longitudinal axis.

31. The method according to claim 16, further comprising forming the elongated composite structural member to substantially exhibit a cross-sectional geometry of a hat as taken transverse to a length of the elongated member.

32. The method according to claim 16, further comprising forming the elongated composite structural member to substantially exhibit a cross-sectional geometry of at least one C-shape as taken transverse to a length of the elongated member.

33. The method according to claim 16, further comprising forming the elongated composite structural member to substantially exhibit a cross-sectional geometry of at least one angle as taken transverse to a length of the elongated member.

34. The method according to claim 16, further comprising forming the elongated composite structural member to substantially exhibit a cross-sectional geometry including at least one arcuate section as taken transverse to a length of the elongated member.

35. The method according to claim 16, further comprising heating the portion of the plurality of plies.

36. An apparatus for forming elongated composite structural members comprising:
a base;
at least one mandrel mounted on the base, the at least one mandrel exhibiting a substantially elongated geometry;
a carriage assembly movably coupled to the base;
at least one roller exhibiting a geometry configured to at least partially complementarily engage the least one mandrel as it rolls there along, the at least one roller coupled with the carriage assembly; and

at least one force applying mechanism configured to apply a desired force to the mandrel through the at least one roller.

37. The apparatus of claim 36, wherein the at least one roller and carriage assembly are mutually configured for the at least one roller to be removed from the carriage assembly and replaced by another roller exhibiting a geometry configured to substantially completely complementarily engage the at least one mandrel.

38. The apparatus of claim 36, wherein the at least one roller comprises a plurality of rollers coupled with the carriage assembly.

39. The apparatus of claim 36, further comprising an automated material dispensing device configured to dispense a plurality of plies of material over the at least one mandrel along a length thereof.

40. The apparatus of claim 39, wherein the automated material dispensing device is configured to dispense the plurality of plies of material including a first ply exhibiting a first width, and at least a second ply exhibiting a second width different than the first width.

41. The apparatus of claim 36, wherein the at least one roller and the at least one mandrel are complementarily configured to form an elongated composite structural member substantially exhibiting a cross-sectional geometry of a hat as taken transversely to a length of thereof.

42. The apparatus of claim 36, wherein the at least one roller and the at least one mandrel are complementarily configured to form an elongated composite structural member substantially exhibiting a cross-sectional geometry of at least one C-shape as taken transversely to a length of thereof.

43. The apparatus of claim 36, wherein the first roller and the at least one mandrel are complementarily configured to form an elongated composite structural member substantially

exhibiting a cross-sectional geometry of at least one angle as taken transversely to a length of thereof.

44. The apparatus of claim 36, wherein the first roller and the at least one mandrel are complementarily configured to form an elongated composite structural member substantially exhibiting a cross-sectional geometry including at least one arcuate section taken transversely to a length of thereof.

45. The apparatus of claim 36, wherein the at least one force applying mechanism includes at least one weight operably coupled to the first roller to press the first roller over the at least one mandrel.

46. The apparatus of claim 36, wherein the at least one force applying mechanism includes a hydraulic system.

47. The apparatus of claim 36, wherein the at least one force applying mechanism includes a pneumatic system.

48. The apparatus of claim 36, wherein the at least one mandrel includes a plurality of mandrels laterally spaced from one another.

49. The apparatus of claim 48, wherein the at least one roller is configured to move laterally with respect to the base and independently engage each of the plurality of mandrels.

50. The apparatus of claim 48, wherein the at least one roller includes a plurality of rollers, and wherein at least one roller of the plurality engages each of the plurality of mandrels.

51. The apparatus of claim 48, wherein the a plurality of mandrels includes a first mandrel exhibiting a first geometric configuration and a second mandrel exhibiting a second geometric different from the first geometric configuration.

52. The apparatus of claim 36, further comprising a heating device configured and oriented to heat at least a portion of any material disposed over the at least one mandrel.

53. The apparatus of claim 52, wherein the at least one heating device is coupled with the carriage assembly.

54. The apparatus of claim 36, further comprising a heating device configured and located to heat the at least one mandrel.

55. The apparatus of claim 36, further comprising a controller operably coupled with the apparatus and configured to control movement of the carriage assembly relative to the base about a plurality of axes.

56. The apparatus of claim 55 wherein the controller is further configured to control operation of the at least one force applying mechanism.

57. The apparatus of claim 56, further comprising an automated material dispensing device configured to dispense a plurality of plies of material over the at least one mandrel along a length thereof, and a heating device configured to and located to provide heat to at least one of the plurality of plies and the at least one mandrel, and wherein the controller is configured to control operation of the automated material dispensing device and the heating device.

58. The apparatus of claim 55, wherein the controller includes a processor, a memory device, at least one input device and at least one output device.

59. The apparatus of claim 36, wherein the at least one mandrel includes a first section extending along a longitudinal axis and a second section which deviates from the longitudinal axis.

60. The apparatus of claim 59, wherein the at least one roller is configured to remain substantially continuously engaged with the at least one mandrel as it moves relative to the base over the first mandrel section and the second mandrel section.